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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/791,904	03/04/2004	Darrell M. Erb	50432-614	4666
7590 10/20/2005				
McDERMOTT, WILL & EMERY		EXAMINER		
600 13th Street, N.W.		SANDVIK, BENJAMIN P		
Washington, DC 20005-3096				
		ART UNIT	PAPER NUMBER	
		2826		

DATE MAILED: 10/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

AK

<b>Office Action Summary</b>	<b>Application No.</b>		<b>Applicant(s)</b>	
	10/791,904		ERB ET AL.	
	<b>Examiner</b>		<b>Art Unit</b>	
	Ben P. Sandvik		2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on 7/15/2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☐ Claim(s) \_\_\_\_\_ is/are rejected.
- 7) ☒ Claim(s) 3, 4, 13, 14, 21 and 24 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \*    c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |   |   |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)             | 4) <input type="checkbox"/> Interview Summary (PTO-413)                     |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)    | Paper No(s)/Mail Date. _____  |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____   | 6) <input type="checkbox"/> Other: _____                                    |

## DETAILED ACTION

### *Claim Objections*

Claims 3, 4, 13, and 14 objected to because of the following informalities: the limitation "the layer of alpha-Ta has a thickness of 25-40 Angstroms" appears to be a typo, and should read beta-Ta instead of alpha-Ta, as in the originally submitted claims. Appropriate correction is required.

### *Claim Rejections - 35 USC § 103*

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 4, 10, 14, 20, 22, 23, and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami et al (U.S. Patent #6346745), in view of Seet et al (U.S. PG Pub #20040131878).

With respect to **claims 1 and 10**, Nogami teaches a first dielectric layer over a substrate (Fig. 1, 12), copper inlaid in the first dielectric layer (Fig. 1, 10 and Col 6 Ln 4-7), and a barrier layer that caps the inlaid copper comprising: a layer of tantalum on an upper surface of the inlaid copper (Fig. 1, 16), a layer of tantalum nitride on the layer of tantalum (Fig. 1, 15), and another layer of

tantalum on the TaN layer (Fig. 1, 13). Note that lines 49-52 in column 5 and 4-15 in column 6 state that the layer 13-16 in Figure 1 are reversed when copper is the lower feature. Nogami does not teach that layer of Ta on the inlaid copper is beta-Ta or that the Ta layer on the TaN layer is alpha-Ta. Seet teaches a layer of beta-Ta deposited over an inlaid copper layer (Fig. 1B, 28 and Paragraph 0119) and also teaches that alpha-Ta can be formed by depositing a Ta layer on a TaN layer (Paragraph 0122). It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the first Ta layer of Nogami as a beta-Ta layer and the second Ta layer as an alpha-Ta layer as taught by Seet in order to optimize the resistivity of the capping layer.

With respect to **claims 4, 14, 22, and 25**, Nogami and Seet disclose the claimed invention except for the exact thickness of the alpha-Ta layer being 200-500 angstroms, but it is taught by Nogami to be 10-150 angstroms. Furthermore, from the thicknesses disclosed in claim 4 of Nogami it is found that the total thickness of the capping layer is in the range 60-750 Angstroms, while the total thickness from the current application is in the range of 245-640 Angstroms. The applicant's disclosure does not specify the critical element of the range, since such a modification would have involved a mere change in the size of a component. A change in size is generally recognized as being within the level of ordinary skill in the art. *In re Rose*, 105 USPQ 237 (CCPA 1955). It would have been obvious to change the size of the alpha-Ta layer in Nogami to be between 200-500 angstroms in order to arrange the individual layers of the capping layer

to have a total thickness in the range of 245-640 Angstroms in order to fit into the recess of the copper inlay and to optimize the electric properties of the capping layer.

Claims 2, 3, 5-8, 11-13, and 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami and Seet, in view of Sudijono et al (U.S. Patent #6706625).

With respect to **claims 2 and 11**, Nogami and Seet teach all of the limitations of claims 1 and 10, respectively, but do not teach that the composite capping layer is formed in a recess in the inlaid Cu such that an upper surface of the alpha-Ta layer is substantially coplanar with an upper surface of the first dielectric layer. Sudijono teaches an inlaid copper portion (Fig. 8, 14) having a capping layer (Fig. 8, 16) that is formed in a recess of the copper portion and having an upper surface coplanar with an upper surface of the first dielectric layer (Fig. 8, 10), wherein the capping layer is planarized by CMP (Col 3 Ln 15-17). It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the capping layer of Nogami and Seet in a recess of the copper portion as taught by Sudijono in order to achieve better electromigration reliability.

With respect to **claims 3 and 13**, Nogami, Seet, and Sudijono disclose the claimed invention except for the exact thickness of the alpha-Ta layer being 200-500 angstroms, but it is taught by Nogami to be 10-150 angstroms. Furthermore,

from the thicknesses disclosed in claim 4 of Nogami it is found that the total thickness of the capping layer is 60-750 Angstroms, while the total thickness from the current application is 245-640 Angstroms. The applicant's disclosure does not specify the critical element of the range, since such a modification would have involved a mere change in the size of a component. A change in size is generally recognized as being within the level of ordinary skill in the art. *In re Rose*, 105 USPQ 237 (CCPA 1955). It would have been obvious to change the size of the alpha-Ta layer in Nogami to be between 200-500 angstroms in order to arrange the individual layers of the capping layer to have a total thickness of 245-640 Angstroms in order to fit into the recess of the copper inlay and to optimize the electric properties of the capping layer.

With respect to **claims 5 and 12**, Nogami and Seet teach all of the limitations of claims 3 and 11, respectively, but do not teach a diffusion barrier lining and opening in the first dielectric layer, and the inlaid copper on the diffusion barrier filling the opening. Sudijono teaches a barrier layer lining an inlaid copper portion and the copper portion filling an opening in the first dielectric layer (Fig. 8, 12 and 14). It would have been obvious to one of ordinary skill in the art at the time the invention was made to line the inlaid copper portion of Nogami and Seet with a diffusion barrier as taught by Sudijono in order to reduce the migration of copper.

With respect to **claims 6, 7 and 16, 17**, Nogami and Seet teach all of the limitations of claims 3 and 11, respectively, and furthermore Nogami teaches an alpha-Ta barrier layer lining an upper dielectric opening (Fig. 1, 16), but do not teach a second dielectric layer over the first dielectric layer, or copper or a copper alloy inlaid in an opening in the second dielectric layer in electrical contact with the upper surface of the alpha-Ta layer. Sudijono teaches a second dielectric layer over the first dielectric layer (Fig. 8, 22) and copper inlaid in an opening in the second dielectric layer, the copper being in contact with the capping layer (Fig. 8, 30). It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide the structure of Nogami and Seet with a second dielectric layer and with copper inlaid in the second dielectric layer and in contact with the upper alpha-Ta layer as taught by Sudijono in order to create a dual damascene structure.

With respect to **claims 8 and 18**, Nogami, Seet, and Sudijono teach all of the limitations of claims 6 and 16, respectively, but Nogami and Seet do not teach an opening in a second dielectric layer that is a dual damascene opening, and that the dual damascene opening is filled with Cu or a Cu alloy forming an interconnect comprising a lower via in contact with an upper line. Sudijono teaches a dual damascene opening in a second dielectric layer, the opening filled with copper, and forming an interconnect comprising a lower via in contact with an upper line (Fig. 8). It would have been obvious to one of ordinary skill in the art at the time the invention was made to fill a dual damascene opening with

copper as taught by Sudijono because copper has favorable conductive properties.

Claims 9 and 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami, Seet, and Sudijono, further in view of Gupta et al (U.S. Patent #6114243).

With respect to **claims 9 and 19**, Nogami, Seet, and Sudijono teach all of the limitations of claims 8 and 18, respectively, but do not teach a composite capping layer on the copper filling the opening in the second dielectric layer comprising a layer of beta-Ta on the copper, a layer of tantalum nitride on the layer of beta-Ta, and a layer of alpha-Ta on the layer of tantalum nitride. Gupta teaches a dual damascene structure having a capping layer between two copper layers and a second capping layer over a top copper layer (Fig. 17, 40). It would have been obvious to one of ordinary skill in the art at the time the invention was made to provide a second composite capping layer as taught by Nogami, Seet, and Sudijono over the top inlaid copper portion as taught by Gupta in order to prevent copper migration from the top inlaid copper portion.

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Nogami, Seet, and Sudijono, in view of Lopatin et al (U.S. Patent #6096648).

With respect to **claim 15**, Nogami, Seet, and Sudijono teach all of the limitations of claim 11, but do not teach that the beta-Ta, tantalum nitride, and alpha-Ta layers are deposited by physical vapor deposition. Lopatin teaches that

tantalum can be deposited by physical vapor deposition (Col 4 Ln 18-22). It would have been obvious to one of ordinary skill in the art at the time the invention was made to deposit the tantalum layers using PVD as taught by Lopatin in order in to use a clean, dry vacuum deposition process.

***Allowable Subject Matter***

Claims 21 and 24 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ben P. Sandvik whose telephone number is (571) 272-8446. The examiner can normally be reached on Mon-Fri.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan Flynn can be reached on (571) 272-1915. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

bps

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